Space Weather Technical Forecast

Issued on Wednesday, 23 November 2022 at 13:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight Chance of R1/R2 radio blackouts. Slight chance of Minor Geomagnetic Storm (G1) intervals.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with a number of C-flares occurring, with peak C4.8 flare at 22/1908 UTC from AR3151 Dai/Beta. This appears to have now matured, with intermediate spots fading. AR3147 Cso/Beta and AR3149 Eso/Beta also persist as mature features but with no notable development ongoing. Weak CMEs were observed, with the one from the C4.8 flare with the potential for Earth-directed component. However this has yet to be fully assessed.

Solar Wind / Geomagnetic Activity: The solar wind at L1, measured by ACE, DSCOVR and SOHO persisted at background levels, declining from 360 km/s to 300 km/s. The density gradually rose, however, increasing from below average levels, to above average reaching 14ppcc at 23/1200 UTC. The total IMF, Bt, was weak below 6 nT with north-south component Bz, varying weakly between +4/-3 nT. Phi angle was predominately negative (towards the Sun) but with brief periods of positive (away from the Sun) Geomagnetic activity remained Quiet (Kp 0-1).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 has remained at Background levels. High energy electron flux (greater than 2MeV) at GOES16 was at background throughout. Electron fluence levels remained below Active (1e8 integrated pfu) levels. Observed fluence at 23/0000 UTC was 1.53e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low, with a slight chance of isolated M-class X-ray flares.

Solar Wind / Geomagnetic Activity: There are two CME's on or close to the Earth-Sun line, however these area low confidence for any arrival. The CME from the C7 flare at 22/0727 UTC is likely to pass south of Earth, underneath its orbit, but may give some peripheral impacts on day 4 (26th). The CME from 23/1906 UTC has yet to be fully analysed. Otherwise current background solar winds have the potential to become enhanced day 1 (23rd) into day 2 (24th) due to the arrival of the fast wind of CH47/+. This is low confidence, however further enhancements are possible through the period, from either the weak passing CMEs or from the arrival of CH48/+ fast winds later. Mainly Quiet geomagnetic activity is likely to increase to Unsettled with a chance of Active intervals and a slight chance of G1/Minor Storms day 1 and day 2 (23rd and 24th). Activity easing to mainly Quiet with isolated Unsettled spells, but still a chance of Active with a slight chance of G1/Minor storm intervals.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) observed by GOES16 is expected to remain at Background levels throughout. The high energy Electron flux (greater than 2 MeV) at GEO is forecast to be close to background at first, before rising to Moderate to High levels later in the period in response to the enhanced solar wind conditions possible later day 1 or day 2 (23rd or 24th). The persistence of any enhancement is

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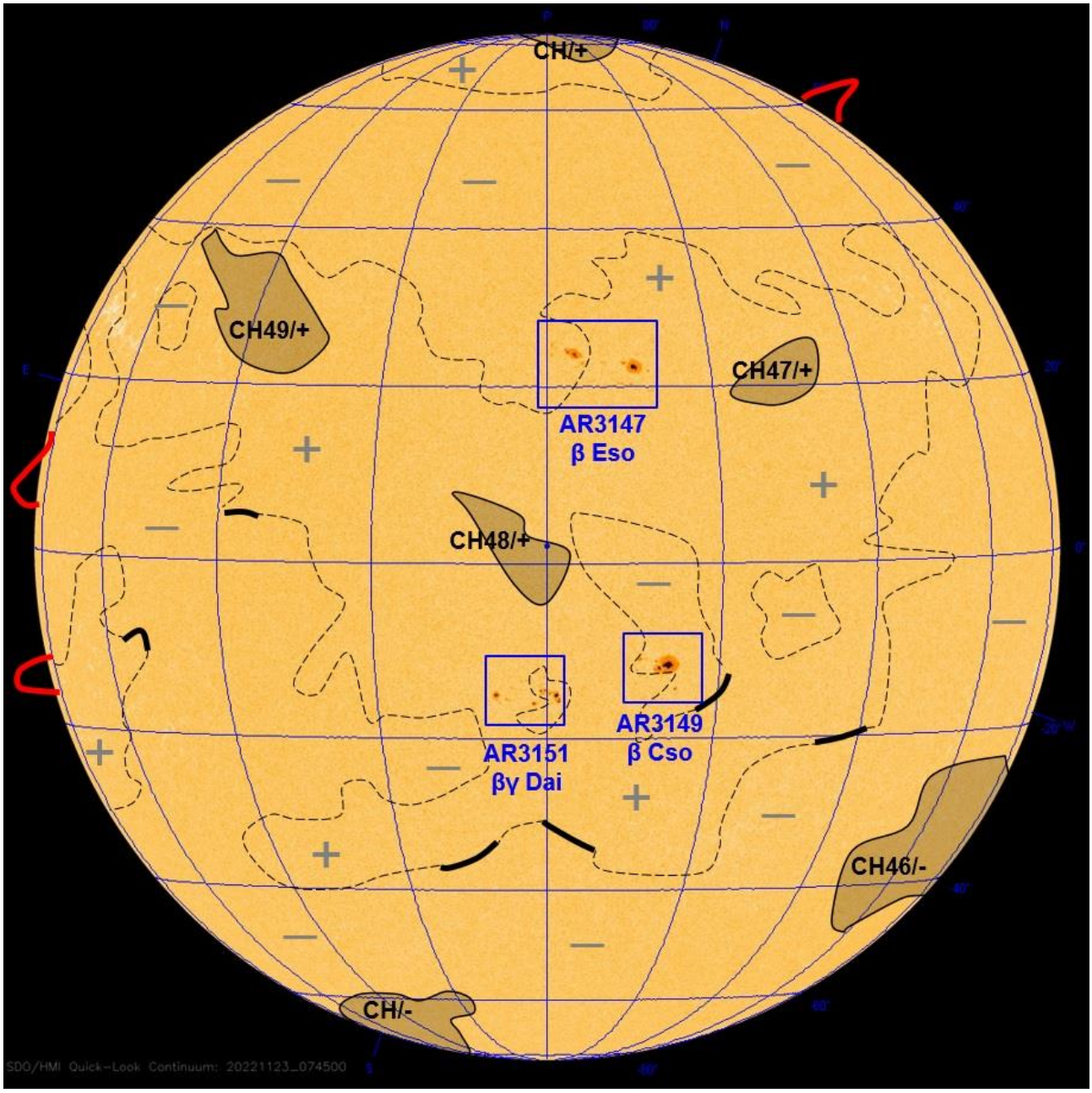
low confidence. The associated 24-hour integrated fluence is expected to remain below Active (1e8 integrated pfu) throughout, albeit with a slight chance of rising above later in the period.

Figure 1. Solar Analysis Valid 23/0800.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are a couple of CME's on or close to the Earth-Sun line, however these area low confidence for any arrival. The CME from the C7 flare at 22/0727 UTC is likely to pass south of Earth, underneath its orbit, but may give some peripheral impacts on day 4 (26th). The CME from 23/1906 UTC has yet to be fully analysed

Solar winds have the potential to become enhanced later on day 1 (22nd) due to the arrival of the high speed stream (HSS) of CH47. This is a low confidence forecast however, as this potential arrival is based upon STEREO A PLASTIC data which showed an enhancement around 22/1800 UTC positioned around 1.2 days upwind of Earth, whilst a similar enhancement is not visible in MOSWOC enlil. However this enhancement would correlate reasonably with 27-day persistence which suggests a weak enhancement on the 23rd, followed by a more definite arrival late on the 24th. Ongoing fast winds are then possible due to any further enhancement from CH48/+, but most likely leading to a re-enhancement on day 4 (26th).

Quiet activity is likely to become Unsettled with a chance of Active intervals later day 1 and day 2 (23rd and 24th) but with isolated G1/Minor storms possible. Activity then easing to be mostly Quiet day 3 and day 4 (25th and 26th), with an ongoing chance of Unsettled to Active intervals, and a slight chance G1/Minor Storms given any further fast wind or CME arrivals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	30	10	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
22/1925	Partial	C7 flare of AR3151	SE	405	Missing	Chance of glance on 26th
22/1900	Partial	C4.8 flare of AR3151	SE	500	Unknown	Analysis still being done.

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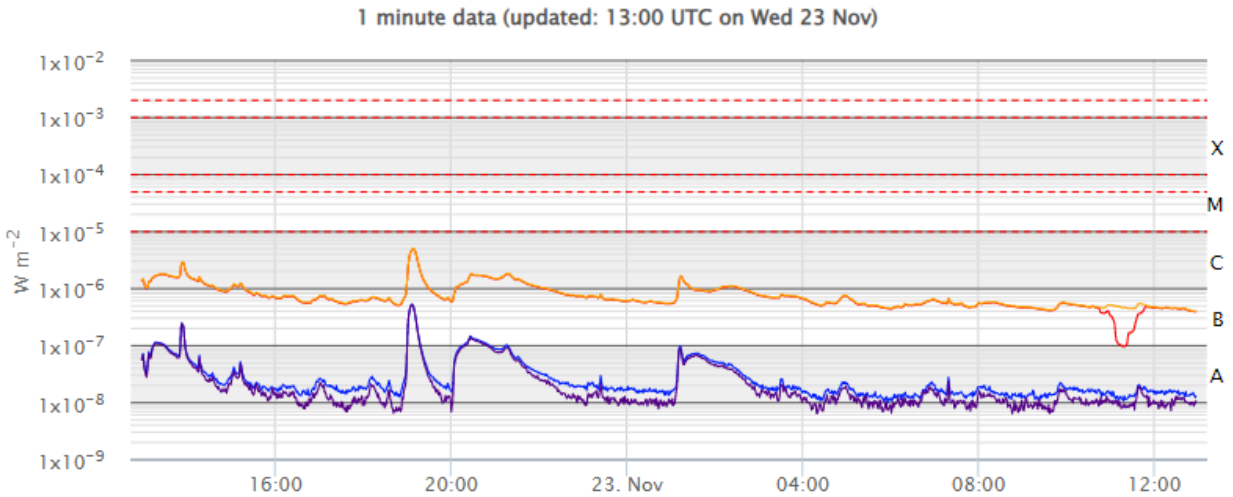
Radio Blackouts - X-Ray Flares:

Low Solar activity is expected through the period, with further C-class flares expected and an ongoing slight chance of M-class flares.

There are three sunspots on the Earth-facing disc, the most active of which is the less mature AR3151 Dai/Beta-Gamma in the southern centre disc, and has been the source of a couple of larger C-flares, including a C5 at 22/1906 UTC. To the west of this region is mature space AR3149 Cso/Beta, which has remained relatively inactive despite some fluctuations in surrounding small spots. AR3147 Eso/Beta in the north centre disc also remains relatively simple and sable with some spreading out of its spots.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	15	15	15	15
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 2: GOES-16/17 X-ray Flux



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES16 is currently at background and expected to persist at this level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) observed by GOES16 is forecast to increase in response to any fast wind arrival through the day 1 and 2 (23rd and 24th). Moderate levels are likely by day 2 (24th), perhaps peaking High later in the period. This is very low confidence however, with the potential fast wind arrival on day 1 and 2 uncertain, and further potential fast wind and CME arrivals by day 4 (26th) potentially suppressing observed flux at GEO later in the period.

The associated 24 hour fluence is forecast to remain below the Active threshold, with a slight chance of rising to Active by the end of the period. REFM is currently maintaining background fluence levels, which is good guidance if the enhancement day 1 or 2 (23rd or 24th) doesn't materialise.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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